Highlights Environmental Management Engineering and Technology

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

WHAT'S INSIDE

Florida International University Partners with DOE to Provide Young Professionals to Fill Gaps in the EM Workforce

DOE and Florida International University (FIU) have recently established a new workforce development program involving hands-on education, training, and mentoring of minority students in technical areas important to EM. Since its inception in 2007, 41 FIU DOE Fellows have participated in this program, generating a "pipeline" of young professionals ready to enter DOE's or DOE's contractor workforce, filling critical gaps in the aging workforce. This new program grew out of a successful FIU-DOE partnership created in 1995, which has trained hundreds of students in development, testing, and deployment of innovative technologies for cleanup of DOE sites. Over that time frame, FIU also established an environmental research and development center, the Applied Research Center (ARC), to engage students in technology development projects focused on problems at 11 DOE sites.

In March, 2009, 16 FIU DOE Fellows actively participated at the annual Waste Management Conference in March 2009 in Phoenix. According to Dr. Leonel Lagos (FIU Program Director), WM09 participants were impressed by the students' 'hands on' DOE-EM research and their knowledge of DOE-EM environmental challenges. "I'm extremely proud of our DOE Fellows and of the progress they have been able to achieve during the last two years. The pipeline is working," said Dr. Lagos. Thirteen of the students presented their research at the Student Poster competition and at professional poster sessions. Their research covered a variety of subjects, including soil/groundwater, deactivation and decommissioning, and waste processing.

Two posters were noted as particularly outstanding:

- Denisse Aranda (Senior Mechanical Engineer – DOE Fellow Class of 2007) won 1st place in the student poster competition for her work on "The Effect of Ultrasound in Dislodging Radioactive Waste from DOE Pipelines."
- Leydi Velez (Senior Industrial Engineer – DOE Fellow Class of 2007) won best poster for her work on the development of a Decision Analysis Tool for Surveillance & Maintenance of DOE Facilities. Since completing an internship at Oak Ridge National Laboratory (ORNL) last summer, Leydi has continued to provide technical support to ORNL staff to further develop the decision model.

During the summer of 2009, 13 of FIU's DOE Fellows participated in a 10-week internship at the ORNL, Idaho, Savannah River, Pacific Northwest National Laboratory, DOE-Headquarters, and two DOE contractor facilities. Two participants are already benefitting from the program. After completing her degree at FIU and a summer internship at DOE Headquarters, DOE Fellow Rosa Ramirez began working full-time for DOE EM through the Professional Development Corps Program. Jose Luis Vasquez, DOE Fellows Class of 2007, has also applied to the Professional Development Corps Program. The longstanding FIU-DOE partnership is contributing substantially to DOE's current efforts to engage young professionals in EM technical areas and promote a smooth transition within the DOE workforce.

The DOE-FIU Fellows Program participants and the Program Director at the 2009 Waste Management Conference.

Investment in Transformational Advancements Can Reduce the Cleanup Program's Greatest Risks

Meeting the Office of Engineering and Technology's (OET) overall goal – to reduce technical risks and uncertainties associated with DOE Environmental Management projects – calls for balancing the OET investment portfolio between incremental and transformational advancements. OET's investment in incremental improvements positively impacts EM Projects in the short-term, while investments in longer-term projects can produce transformational solutions to the most challenging EM problems.

For EM, "transformational" investments refer to those research projects with the potential to significantly impact the way that EM manages the cleanup for its largest projects. The benefits can be measured in terms of saving billions of dollars or greatly reducing project schedules for completion.

One such example is the Office of Waste Processing's immobilization research focused on providing new solutions for treatment of high-risk waste streams at Hanford, Savannah River, and Idaho. Investments in next-generation melter technology, advanced glass/waste-form formulations, and supplemental treatment technologies have the potential to transform the way these high-risk waste streams are treated. » »

Next year, the next-generation melter technology program will convene an international technical exchange and will issue a call for research and development proposals to further this research. Advanced glass/waste-form formulations activities will include expansion of glass property data and models as well as phosphate glass research. Supplemental treatment technology research will involve advanced waste forms for Idaho National Laboratory high-activity waste and Hanford low-activity waste and secondary wastes.

The Office of Groundwater and Soil is investing in transformational improvements by supporting research in 1) delivery of treatment media to the subsurface for in situ treatment, and 2) computational modeling to enable improved understanding of subsurface contaminant fate and transport and better predictions of long-term conditions at sites that have undergone treatment or are being considered for natural attenuation.

OET's investment in incremental improvements positively impacts EM Projects in the short-term, while investments in longer-term projects can produce transformational solutions to the most challenging EM problems.

Current research on the use of foam for delivery of treatment media is under way at both the laboratory and intermediate scale at Pacific Northwest National Laboratory and MSE Technology Applications, Inc. facilities. If successful, this work could result in a new way to effectively deliver treatment media to the deep vadose zone at sites in the western U.S., transforming the way remediation of the vadose zone is performed.

Another transformational investment is being planned to develop advanced modeling capabilities for understanding contaminant transport, fate, and remediation issues across the EM complex. This research can contribute to 1) establishing consistency in performance assessments, which typically provide the basis for predictions regarding long-term performance of remedial systems; 2) institutionalizing a closure methodology for EM sites; and 3) enhancing application of natural attenuation as a significant component of the remedial systems. These improvements will also result in greater stakeholder and regulatory confidence in EM's cleanup activities for soils and groundwater.

New Decontamination Gels Successfully Remove/Reduce Radionuclides from Surfaces of Buildings and Equipment

With support from the Office of Deactivation and Decommissioning and Facility Engineering, Cellular Bioengineering, Inc. (CBI) has developed and successfully demonstrated several decontamination gels (DeconGel™ 1101, 1120, and 1121) to remove/reduce radionuclides from building and equipment surfaces. With this method of removing radioactive contamination, doses of radioactivity to workers can be reduced and the facilities can be either reused or disposed in non-radioactive waste areas, significantly decreasing disposal costs. Because DOE owns many facilities needing to be deactivated and decommissioned, the new gels offer an improved tool that can positively impact worker safety and project cost and schedule.

The hydrogel coating can be applied to horizontal, vertical, and inverted surfaces on most substrates, including bare, coated, and painted concrete, aluminum, steel, lead, rubber, Plexiglas®, herculite, wood, porcelain, tile grout, and vinyl, ceramic, and linoleum floor tiles. Contamination is removed in a peelable film that can be disposed according to appropriate local, state, and federal regulations. The new gels can also be used to remove particulates, metals, and insoluble organic compounds from surfaces.

A gel is brushed on a contaminated surface and dried to produce a film containing the radionuclides, which can be peeled off and disposed according to regulations.

Demonstrations of the new technology have been completed as follows:

- **At Oak Ridge National Laboratory Building 2026,** DeconGel™ 1101 was applied to a 600-square-foot floor area and tracks behind the hot cells and DeconGel™ 1121 was sprayed and painted on the walls and hot cell doors adjacent to the floor area. This facility was posted as an airborne contamination area requiring double anti-contamination suiting and full-face respirators for entry. The initial application removed about 50% of the alpha and beta transferable contamination. Areas not previously treated with sealants or fixatives showed removal efficiencies greater than 90%. However, previously treated surfaces required an additional application to improve the removal efficiency. A second gel application on the tracks increased the removal efficiency to greater than 62% of the transferable alpha contamination and 37% of transferable beta contamination.
- **At Lawrence Livermore National Laboratory** in California, the new gel was used to remove plutonium-238 from glove boxes composed of aluminum, cast steel, and Lexan. After three applications of the gel, more than 99% of the contamination was removed. Because the gel is easy to apply, the number of labor hours required to perform the decontamination was significantly reduced
- **At Sandia National Laboratory** in New Mexico, the DeconGel™ 1101 was tested on concrete, carbon steel, stainless steel, and Plexiglas surfaces containing americium, plutonium, and cesium. After 24 hours, the gel coatings were easily removed from the surface. Removal rates after the single application generally ranged from 15% to more than 99% for cesium, while those for americium and plutonium ranged from 53% to more than 99%.
- **At Alaron Nuclear Services** in Wampum, Pennsylvania, a variety of surfaces were decontaminated with removal efficiencies ranging from 90 to 100% of the loose beta activity for a wide variety of radioactive isotopes. A single gel application on the cylindrical surface of a storage cask reduced loose beta contamination by 90%, whereas similar applications on the cap of the cask and on the floor removed 98% and 99% of the loose beta contamination.

These new decontamination gels can be an effective way to reduce or eliminate contamination on building surfaces and equipment, while also improving worker safety and reducing

requirements for personnel protection equipment. Ultimately, decontamination of building and equipment surfaces will reduce disposal costs, as the debris often does not require disposal in a radioactive landfill, which is significantly more expensive than other types of landfills. In some cases, the equipment can be reused rather than disposed. The decontamination gels also can reduce costs and accelerate schedule. Further refinements of the existing DeconGels and development of improved isotope-substrate specific gels and gels intended for the decontamination of other substances (e.g., beryllium, mercury) will be initiated in FY 2010.

Microorganisms are Naturally Degrading Solvents in Groundwater at the DOE Paducah Site in Kentucky

Dr. Hope Lee, Idaho National Laboratory, has used innovative molecular and geochemical methods, such as the enzyme activity probe (EAP), to document that microorganisms are naturally degrading chlorinated solvents, like trichloroethylene (TCE), in large, oxygen-rich groundwater plumes. These methods have demonstrated that this natural degradation or attenuation can be a key process for cleanup of large contaminant plumes. If natural attenuation is included as part of the remedial systems at these sites, billions of dollars can be saved during cleanup and site closure.

Natural attenuation involves a variety of processes that act, without human intervention, to reduce the mobility, concentration, or toxicity of contaminants in groundwater.

As part of the Savannah River National Laboratory (SRNL) Monitored Natural Attenuation (MNA) Project, Dr. Lee led the TCE Fate and Transport Team's investigation in the Regional Gravel Aquifer (RGA) at the DOE Paducah Site in Kentucky. Researchers found that 90 percent of the groundwater samples from 10 wells within the Northwest Plume at Paducah contained microorganisms that can degrade TCE. To understand the overall impact of the microbial processes on plume cleanup, a kinetic study is underway at the Paducah Northwest Plume to determine how rapidly the microorganisms are degrading TCE.

Dr. Lee demonstrates the innovative enzyme activity probe method to evaluate the natural capacity of indigenous microorganisms to degrade contaminants in groundwater.

To further her research, Dr. Lee has received funding from the Department of Defense Environmental Security Technology Certification Program (ESTCP) and DOE EM to study this microbial process, called cometabolic degradation, at diverse sites with large groundwater contaminant plumes in varying climatic and geological conditions across the U.S. TCE is one of the most widespread groundwater contaminants in the U.S. and typically occurs in large plumes, many of which are highly oxygenated and could benefit from these natural attenuation studies. DOE sites that contain these types of groundwater plumes include Savannah River, Paducah, Brookhaven, Lawrence Livermore, Hanford, and Idaho. Dr. Lee's research can provide a basis for a safe, protective, technically-based, and cost-effective natural attenuation approach to be included in the remedial strategies at many of these sites that were traditionally assumed to require decades to centuries of costly active treatment.

Cometabolism is the simultaneous microbial degradation of two compounds. Some microorganisms use naturally occurring methane or toluene as a food source, thus releasing enzymes that degrade chlorinated solvents.

Environmental Protection Agency natural attenuation guidance requires demonstration and quantification of multiple lines of evidence to demonstrate degradation processes to enable prediction of whether the site will meet cleanup goals within a reasonable timeframe. The EAP method, when used in combination with deoxyribonucleic acid (DNA) confirmation, provides a cost-effective toolkit to identify and quantify the microorganisms that are actively degrading contaminants and producing harmless byproducts, such as carbon dioxide and chloride ions.

These exciting results offer tremendous potential to establish a new paradigm for remedial systems at many DOE sites, where natural attenuation can become a significant component of the groundwater remedial systems.

Technical Exchange Maximizes the Benefits of the EM Technology and Engineering Program

Nearly seven years ago, the three major DOE sites (Hanford-Office of River Protection [ORP], Savannah River Site, and Idaho National Laboratory) recognized the need for better and more frequent communications among the sites' management and technical staff to address waste processing needs. Since then, the DOE EM Office of Waste Processing has sponsored technical exchanges to review progress and issues related to clean up of high-level waste (HLW). These exchanges provide key input for continuously improving the investments of the Waste Processing Technology and Engineering Program to address EM's enormous cleanup challenges that include treatment and disposition of approximately 90 million gallons of HLW contained in underground storage tanks at the DOE Hanford, Savannah River, and Idaho Sites.

Most recently (May 2009), the Office of Waste Processing sponsored a Technical Exchange in Denver, Colorado, to facilitate communication regarding recent and planned activities among the technical and management staff from each of the three major EM sites, the Defense Nuclear Facilities Safety Board (DFNSB), DOE national laboratories, universities, and private industry. Approximately 145 people attended the event with numerous others participating via live webcam. Presentations for the technical sessions focused on waste retrieval and closure, waste form development, waste pretreatment and treatment, facility readiness and

start-up, regulatory acceptance and performance assessment, waste storage and tank farm operational improvements, plus a senior manager's panel discussion.

Each of the three major sites has unique challenges related to safe storage, retrieval, pretreatment, treatment/stabilization, and tank closure activities for HLW and transportation and disposal activities for low-activity waste. Many of the challenges require first-of-a-kind technologies. Guided by the EM Engineering and Technology Road Map (March 2008), staff from the three sites participate in the Office of Waste Processing Strategic Initiatives for R&D:

- improved waste storage
- reliable and efficient waste retrieval
- enhanced tank closure processes
- next-generation pretreatment solutions
- enhanced stabilization.

At the most recent Technical Exchange, the three major EM sites reported on the status of their HLW programs and current technology development efforts. Others involved in related EM Engineering and Technology R&D efforts, such as immobilization research and organizational developments, reported their latest results as well.

A senior manager from the Savannah River Site HLW Program reported that progress during the last year included the following:

- treatment of about 1.5 million gallons of a planned total of 2.5 million gallons of waste using the Deliquification, Dissolution, and Adjustment Process;
- treatment (removing strontium-90 and actinides) of 285,000 gallons of a planned total of 1.2 million gallons/year of salt waste using the Actinide Removal Process;
- cleaning of two HLW tanks, using oxalic acid.

Hanford ORP reported that development continues for waste retrieval technologies and technologies that may reduce the treatment time in the Waste Treatment Plant. The development of the Mobile Arm Retrieval System and Enhanced Chemical Cleaning are two key technology development projects to address site needs.

At the Idaho Cleanup Project, the major technology challenge is treatment and disposition of sodium-bearing waste using steam reforming, with the Office of Waste Processing actively engaged during the last few years to support the development of this technology prior to its full-scale implementation. The sodium-bearing waste treatment project construction was recently reported as 26 percent complete.

Researchers at a poster session at the 2009 Waste Processing Technical Exchange.

Also, the senior managers' panel session provided attendees with valuable insight into key technical challenges for the three major EM sites, development of transformational technologies, and ways to achieve better communication among the sites.

The greatest technical challenges for waste processing at these sites were described as follows:

- **At Savannah River:** performance baseline of the new contract calls for closure of 22 HLW tanks within eight years and a processing rate of up to 400 canisters of HLW at the Defense Waste Processing Facility, the Savannah River Site vitrification plant.
- **At Hanford's ORP:** the closeout of external review comments on the Waste Treatment Plant flow sheet, completion of construction of the plant, retrieval of tank heels, and obtaining sufficient storage space for retrieved waste in the Tank Farms.
- **At Idaho:** accommodating the variability in the waste feed for the steam reforming treatment facility.

For all three sites, the senior managers indicated that the Engineering and Technology Roadmap provides a key tool to identify transformational technologies to be developed to enable significant improvement to the schedule and costs currently planned for HLW processing. However, they also recognized that each site must balance its contract performance requirements against the technology development. All senior managers agreed that the Technical Exchange is a valuable communication tool that complements regularly scheduled multisite conference calls. Conference presentations are located online at **http://srnl.doe.gov/owp_techex09/index.htm**, under Web Cast On-Demand.

CONTACT

Mark Gilbertson
U.S. Department of Energy
ATTN: Office of Environmental Management
1000 Independence Ave., SW
Washington, DC 20585

(202) 586-5042
mark.gilbertson@em.doe.gov
http://www.em.doe.gov/EM20Pages/EM20HomePage.aspx